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A Manufacturer Cannot Survive on SPC Alone: Using Historical Waveform Data to Improve Productivity

The concept of using historical information to improve processes has been in use for many years. The most common form in manufacturing is Statistical Process Control (SPC). SPC uses historical data to provide an indication of future performance. A much less commonly used approach is to use the raw test data (waveforms) collected directly from the sensor monitoring the process. This article focuses on the advantages of utilizing historical waveforms in addition to traditional SPC.

The primary benefit of a waveform over a single, discrete data point is that it provides a complete picture of the behavior of the manufacturing process, not just a single characteristic. Even when multiple feature points are taken from a single waveform, it only provides information from a single point in time. For example, if the maximum value recorded is in a force versus distance measurement you will only know that single value. You do not know where the maximum occurred and if the value was reached gradually or was a spike in the process. Often how a result was arrived at is just as important as achieving it. This is why the entire process, and not just a single point, is monitored during production.

Given access to historical waveforms, there are many ways you can utilize the information contained within them to improve productivity. The two we are examining are:

1) Yield optimization
2) Minimizing cycle time

Optimizing yield with waveforms can be done by ensuring tests are setup correctly. SPC can help by providing a means to set appropriate test limits. However, the waveforms are the key to identifying the root cause of parts that are failing. This is especially important for processes that are producing a large deviation in test results. For example, it's one thing to know that a lot of parts are failing a leak test due to a high flow rate. It's a completely different thing to understand how the final flow rate is being arrived at. This understanding allows the engineer to focus their root cause analysis on the most probable cause. They can quickly determine if the cause is the part, test system or operator error.

The histogram below shows the flow rate measurement for a leak test at the end of the test cycle. A determination is made of “good” or “bad” part based on this value being between the specified limits. The histogram does not show a consistent pattern in the failures. However, when we examine the waveforms it becomes clear that there are two failure modes. One has a constant flow rate at approximately 180 ccm that, in this case, indicates a failure in the test setup, not a part failure. The other failures have a flow rate that does not decrease as far as the “good” parts. This is likely a part specific, and not test process, specific issue. Two other interesting points can also be observed. Some parts that passed the test exhibit a slow steady decline in flow from the 13 second point. This is not consistent with the larger portion of other conforming parts which of a very quick decline in flow.

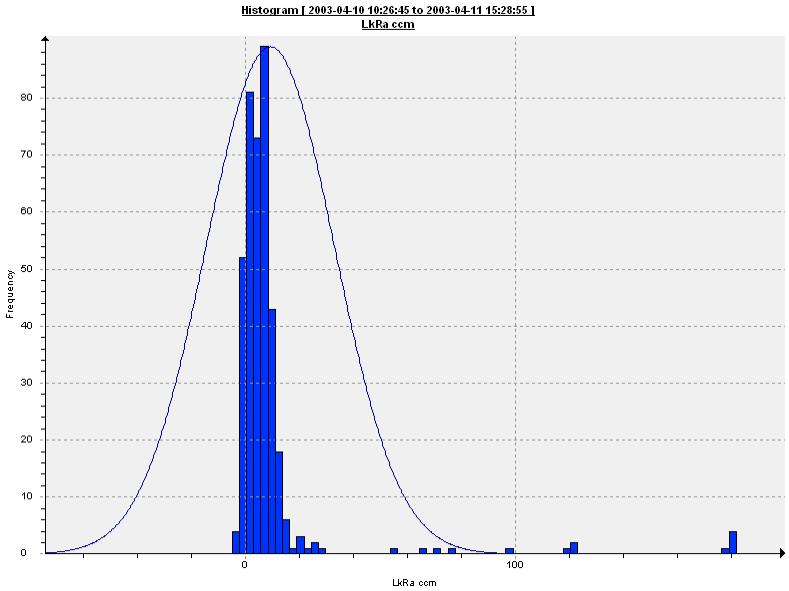

Figure 1: Histogram of leak test flow rate.

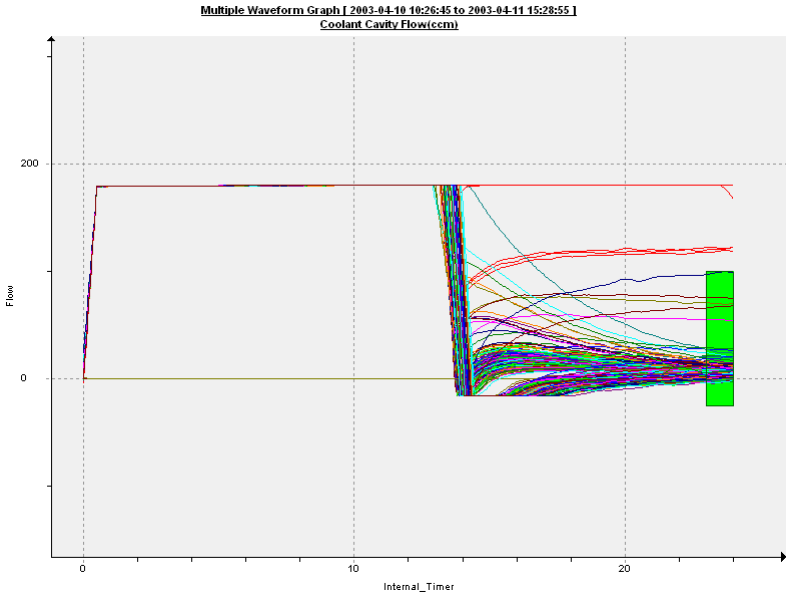

Figure 2: Leak test sensor data. The green region indicates the area in which the flow rate reading is taken for the figure 1 data. The read waveforms indicate parts that exceeded the specified limits.

Minimizing cycle time helps reduce overtime costs and can even reduce the amount of equipment required. This is especially true at end of line functional tests that are typically a bottleneck in a manufacturing line. Examining the waveforms allows you to determine if a test has been optimized or has unnecessary delays. Referring again to figure 2, it can be seen that the analysis could be done five seconds sooner in the test with no change in the yield, or even which parts pass and fail the test. A larger population of waveforms could be used to confirm this hypothesis holds true over a longer period of time. This simple change would represent a 20% reduction in cycle time.

Waveforms are critical to understanding how your part is behaving during the assembly and test process. They move process improvement from reactive to proactive. It also greatly simplifies the trouble shooting process for engineers. This is vital in today's market place where efficiency and brand quality are essential to being a successful manufacturer.

For information on a tool that will help you conduct historical analysis, visit www.qualityworx.com.